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EDGEWOOD ARSENAL  
TECHNICAL MEMORANDUM

EATM 134-2

VISCOSITY OF VX IN THE TEMPERATURE RANGE  
-4° TO -40°F (U)

by

Donald Fielder  
E 4 Robert E. Beck

May 1969

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**EDGEWOOD ARSENAL  
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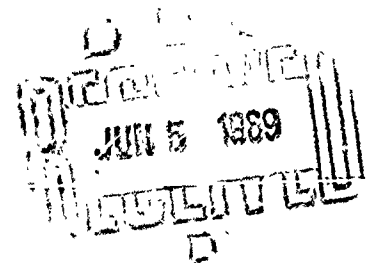
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EDGEWOOD ARSENAL TECHNICAL MEMORANDUM

EATM 134-2

VISCOSITY OF VX IN THE TEMPERATURE RANGE  $-4^{\circ}$  TO  $-40^{\circ}$  F (U)

by

Donald Fielder  
E-4 Robert E. Beck

Physical Chemistry Department  
Chemical Research Laboratory

May 1969

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Task (1B522301A060-07-01)  
1B562602A060-07-01

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FOREWORD

The work described in this report was conducted under Task 1B522301A060-07-01, G and V agents (U). This work was started and completed in April 1968. The experimental data are contained in notebook no. 7701.

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Acknowledgment

The authors wish to acknowledge the technical assistance of the personnel of the Analytical Chemistry Department in performing the analyses.

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### DIGEST

The purpose of this investigation was to determine the viscosity of VX at subambient temperatures. This was accomplished by using Cannon viscometers in a low temperature bath. The viscosity of VX at  $-4^{\circ}$ ,  $-22^{\circ}$ , and  $-40^{\circ}$  F was 182.4, 630.7 and 3,261.5 centistokes, respectively. The viscosity of VX which contained 2.5 wt % N,N'- diisopropyl carbodiimide (ICDI) was 203.9, 722.2 and 3,773.6 centistokes at  $-4^{\circ}$ ,  $-22^{\circ}$  and  $-40^{\circ}$  F, respectively.

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(C) VISCOSITY OF VX IN THE TEMPERATURE RANGE  $-4^{\circ}$  TO  $-40^{\circ}\text{F}$  (U)

### I. (U) INTRODUCTION

(U) The design, and ultimately, the successful testing of a dissemination system for a liquid agent requires a knowledge of the temperature-viscosity relationship of the agent. The Air Force, in their development of a dissemination system for VX, requested information on the viscosity of VX at  $-40^{\circ}\text{F}$ . A search of the literature revealed that the only published viscosity data<sup>1</sup> were for temperatures  $77^{\circ}\text{F}$  and above. However, some unpublished data had been obtained at Edgewood Arsenal in 1957 which indicated that the viscosity of VX at  $32.90^{\circ}\text{F}$  was 35.4 centistokes and 25,590 centistokes at  $-57.46^{\circ}\text{F}$ .

(U) This investigation was undertaken to determine the viscosity of VX at  $-4^{\circ}$ ,  $-22^{\circ}$ , and  $-40^{\circ}\text{F}$ .

### II. (C) EXPERIMENTATION

#### A. Materials

(C) Two samples of VX used in this study had purities of 93.5 and 88.6 wt %. The latter contained 2.5 wt % N,N'-diisopropyl carbodiimide (ICDI).

#### B. (U) Methods

(U) The viscosities of the VX samples were determined by using calibrated Cannon viscometers which had been cleaned and dried for 24 hours under vacuum at  $230^{\circ}\text{F}$ . The viscometers were loaded with the proper quantity of VX under a nitrogen atmosphere in a dry box and capped with drying tubes containing a desiccant. They were transferred to a Rosemount Engineering\* Temperature Calibration Bath (stabilized to  $\pm 0.02^{\circ}\text{F}$ ) using ethylene glycol-water as the bath fluid. The bath was constructed of a stainless steel Dewar which prevented direct observation of the flow of the samples through the viscometers. Observation of the menisci flowing past the reference points on the viscometers was accomplished by using a rigid fiber optic rod which was 1 foot long,  $\frac{1}{4}$  inch in diameter and bent to an angle of  $80^{\circ}$ . Illumination of the reference points on the viscometers was achieved by employing a cladded Lucite light rod equipped with a high intensity light source.

<sup>1</sup> Coulter, P. B., Callahan, J. J., Link, R. S. Physical Constants of 13 V-Agents, CWLR 2346, Dec 1959. (The report is classified Secret).

\* The use of a company name indicates a source of material and is not to be construed as an endorsement of the product.

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(U) The temperature of the bath was monitored with a Hewlett-Packard Quartz thermometer which had a resolution capability of 0.00018°F. The flow time was measured with a mechanical stopwatch.

### III. (U) RESULTS

(U) The experimental data for the viscosity of the two VX samples are listed in the following table:

<u>VISCOSITY OF VX (U)</u>		
<u>Sample</u>	<u>Temperature</u>	<u>Viscosity</u> <sup>(1)</sup>
	°F $\pm$ 0.02°	centistokes
VX	-4.00	182.4 $\pm$ 0.6
	-22.00	630.7 $\pm$ 1.5
	-40.00	3,261.5 $\pm$ 2.4
VX W/ICDI	-4.00	203.9 $\pm$ 1.0
	-22.00	722.2 $\pm$ 1.3
	-40.00	3,773.6 $\pm$ 1.9

(1) Standard deviation of 4 determinations

### IV. (U) DISCUSSION

(U) The data in the above table, along with the two previously unreported viscosity values at 32.90°F and -57.46°F were plotted on American Society for Testing and Material (ASTM) Standard Viscosity-Temperature Chart (see Chart). These data show good agreement although they are for three different samples of VX.

(U) The viscosity values obtained in this investigation were reproducible to better than  $\pm$  0.5% over the temperature range studied.

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### V. (C) CONCLUSION

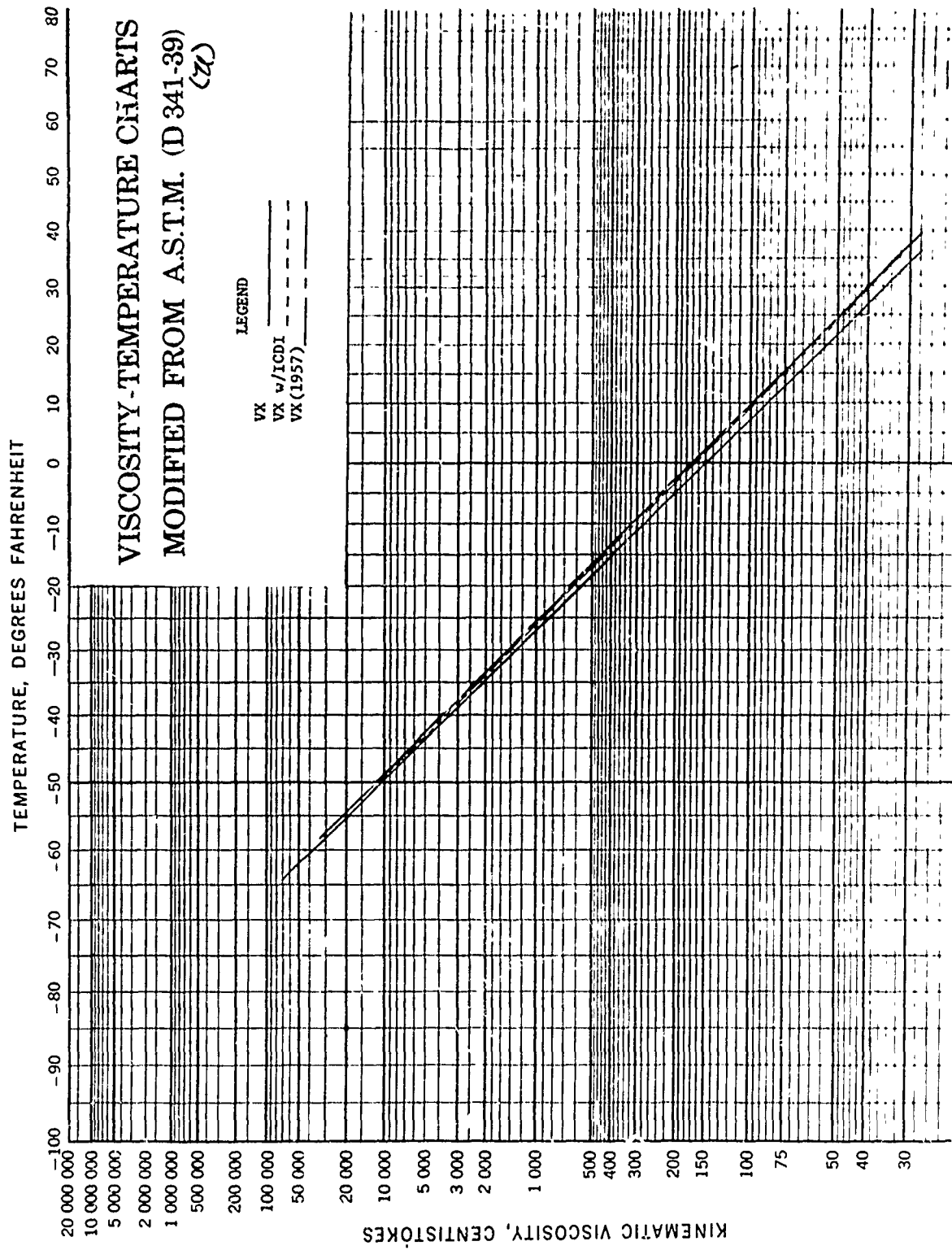
(U) a. The viscosity of VX obtained in this investigation at  $-4.00^{\circ}$ ,  $-22.00^{\circ}$ , and  $-40.00^{\circ}$  F agrees very well with previously unpublished VX viscosity values obtained at  $32.9^{\circ}$  and  $-57.46^{\circ}$  F in 1957, when plotted on ASTM Viscosity Temperature chart paper.

(U) b. The viscosity of VX was determined to be 182.4 centistokes at  $-4.00^{\circ}$  F, 630.7 centistokes at  $-22.00^{\circ}$  F, and 3,261.5 centistokes at  $-40.00^{\circ}$  F.

(C) c. The viscosity of VX containing 2.5 wt % ICDI was determined to be 203.9 centistokes at  $-4.00^{\circ}$  F, 722.2 centistokes at  $-22.00^{\circ}$  F, and 3,773.6 centistokes at  $-40.00^{\circ}$  F.

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11. SUPPLEMENTARY NOTES NA		12. SPONSORING MILITARY ACTIVITY NA	
13. ABSTRACT (U) The viscosity of two VX samples, one of which contained N,N'-diisopropyl carbodiimide, were determined in the temperature range from $-4^{\circ}$ to $-40.0^{\circ}$ F using Cannon viscometers in a temperature calibration bath.			
14 (U) KEYWORDS  Viscosity Centistokes Cannon viscometers VX Temperature calibration bath Fiber optic rod Cladded light rod Subambient temperatures			

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MEMORANDUM FOR Defense Technical Information Center (DTIC), 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218.

SUBJECT: Change in Limitation (Public Release of Information)

1. The purpose of this memorandum is to recommend the Release of Information to the General Public regarding Edgewood Arsenal Technical Memorandum (EATM 134-2), Viscosity of VX in the Temperature Range -4 degrees - -40 degrees F, dated May 1969; and Edgewood Arsenal Technical Report (EC-TR-76058), The Vapor Pressure of Chemical Agents GD, VX, EA 2223, EA 3547, EA 3580, EA 5365 and EA 5593, dated August 1976. The first memorandum was Confidential and was previously downgraded to Unclassified on 20 Mar 1978. The DTIC Number is AD-501931. The second report is Unclassified and the DTIC Number is ADB-013164.
2. This document has been reviewed by Subject Matter Experts from the Edgewood Chemical Biological Center (ECBC) on Aberdeen Proving Ground, Maryland and deemed releasable to the General Public. Request that this document be properly identified and appropriately marked.
3. As the Security Manager for the documents in question, I concur with the recommendations made by the ECBC Review Team.
4. Point of contact for this action is the Information Security Officer, Ronald Stafford at 410-436-6810 or the undersigned at 410-436-7232.

Encl

*June K. Sellers*  
JUNE K. SELLERS  
ECBC Security and Surety Manager